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BI-AXIAL SWIVEL ASSEMBLY IN ELECTRONIC APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electronic apparatus such as a cellular or mobile phone terminal. In particular, the invention relates to a cellular phone terminal of a so-called flip or clamshell type.

2. Description of the Prior Art

A cellular or mobile phone terminal of a so-called clamshell type, including a bi-axial swivel assembly, is well known as disclosed in Japanese Patent Application Publication 2005-023958. The cellular phone terminal includes a main enclosure and a display enclosure. The bi-axial swivel assembly includes a support shaft fixed to the main enclosure. A support member is supported on the support shaft for relative rotation. A bracket is coupled to the support member for relative rotation around the rotation axis perpendicular to an imaginary plane including the longitudinal axis of the support shaft. The display enclosure is coupled to the bracket.

An annular groove is formed around the support shaft. A pair of parallel imaginary planes serve to define the opposite sides of the groove. The imaginary planes extend perpendicular to the longitudinal axis of the support shaft. Recesses are defined in the sides of the groove at a predetermined angular position. The recesses in cooperation defines an enlarged section of the groove. When the display enclosure takes a standard attitude, a cam member integral with the bracket is located inside a space between the parallel imaginary planes. The cam member is allowed to move along the groove over the entire length. The bracket is allowed to rotate around the support shaft over an angular range of 180 degrees, for example. When the display enclosure rotates around the rotation axis by 90 degrees from the standard attitude, the cam member protrudes outside a space between the parallel imaginary planes. The cam member is only allowed to move in the groove within the enlarged section. The rotation of the display enclosure is thus restricted around the support shaft. Moreover, the standard attitude of the display enclosure can always be maintained when the cam member stays outside the enlarged section in the groove.

Electric connection must be established between the display enclosure and the main enclosure in the aforementioned cellular phone terminal. A wire is wound around the bracket in the direction around the rotation axis so as to establish the electric connection. The wire is forced to suffer from a larger flexure every time the display enclosure or bracket rotates around the rotation axis. The wire is also forced to suffer from a larger flexure every time the display enclosure rotates around the support shaft. The wire in this manner suffer from a frequent load.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide a bi-axial swivel assembly capable of relieving a load applied to a wire.

According to a first aspect of the present invention, there is provided a bi-axial swivel assembly comprising: a pair of coaxial bearings located at positions distanced from each other; a pair of support shafts respectively supported on the bearings for relative rotation; a first hollow space extending at least within one of the support shafts in the axial direction of the support shaft, said first hollow space penetrating through the bearing corresponding to the one of the support shafts; a

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support member interposed between the support shafts, said support member coupled with the support shafts based on integral formation; a tube supported on the support member, said tube extending along the rotation axis perpendicular to an imaginary plane including the longitudinal axis of the support shaft; a second hollow space extending within the tube in the axial direction of the tube, said second hollow space penetrating through at least the support member; a bracket supported on the tube for relative rotation around the rotation axis; a perpendicular surface defined on at least one of the bearings along an imaginary reference plane perpendicular to the longitudinal axis of the support shaft; a restriction cam coupled to the bracket, said restriction cam extending in the centrifugal direction of the rotation axis, said restriction cam lying inside the imaginary reference plane when the bracket takes a first attitude, said restriction cam protruding outside the imaginary reference plane when the bracket takes a second attitude established through rotation by 90 degrees around the rotation axis from the first attitude; and a recess formed on the perpendicular surface, said recess receiving the restriction cam protruding outside the imaginary reference plane.

The bi-axial swivel assembly allows the rotation of the bracket and support shafts around the longitudinal axis of the support shaft as long as the restriction cam lies inside the imaginary reference plane. The attitude of the bracket is allowed to change relative to the bearings around the longitudinal axis of the support shaft. Only if the restriction cam is located off the recess, the perpendicular surface serves to prevent the restriction cam from protruding outside the imaginary reference plane. The restriction cam is prevented from rotation around the rotation axis. The attitude of the bracket can also be prevented from changing around the rotation axis. On the other hand, when the restriction cam is positioned within the recess, the restriction cam is allowed to protrude outside the imaginary reference plane through the rotation around the rotation axis. The bracket is thus allowed to rotate around the rotation axis over the angular range of 90 degrees. The attitude of the bracket is allowed to change around the rotation axis at specific position around the longitudinal axis of the support shaft.

The bi-axial swivel assembly allows the wire to penetrate through the first and second hollow spaces. Even in the case where the bracket rotates around the longitudinal axis of the support shaft, the wire is only forced to suffer from a slight torsion within the first hollow space. The wire can be protected from a larger flexure. Even in the case where the bracket rotates around the rotation axis, the wire is only forced to suffer from a slight torsion within the second hollow space. The wire can be protected from a larger flexure also in this case. The wire can in this manner relieved from a load to the utmost. Disconnection and short of the wire can be avoided.

The support member may support the tube at a position off the longitudinal axis of the support shaft in the bi-axial swivel assembly. The bi-axial swivel assembly of the type enables a reliably provision of the first hollow space on the longitudinal axis of the support shaft. This enables the location of the wire closest to the longitudinal axis of the support shaft. The wire is thus reliably prevented from a larger flexure.

The bi-axial swivel assembly of the type can be incorporated into an electronic apparatus such as a cellular or mobile phone terminal. The cellular phone terminal may comprise: first and second enclosures; a pair of coaxial bearings attached to the first enclosure at positions distanced from each other; a pair of support shafts respectively supported on the bearings for relative rotation; a first hollow space extending at least within one of the support shafts in the axial direction of